1223954

# THE UNITED STATES OF AMERICA

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UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

*September 10, 2004*

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**APPLICATION NUMBER:** *60/496,426*
**FILING DATE:** *August 20, 2003*
**RELATED PCT APPLICATION NUMBER:** *PCT/US04/25366*

Certified by

Jon W Dudas

Acting Under Secretary of Commerce
for Intellectual Property
and Acting Director of the U.S.
Patent and Trademark Office

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PTO/SB/16 (02-01)
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17497 U.S. PTO
60/496426
08/20/03

# PROVISIONAL APPLICATION FOR PATENT COVER SHEET

**This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).**

Expr ss Mail Label No. EL995079232US

| INVENTOR(S) | | |
|---|---|---|
| Given Name (first and middle [if any]) | Family Name or Surname | Residence (City and either State or Foreign Country) |
| Jill MacDonald | Boyce | Manalapan, New Jersey |
| Cristina | Gomila | Princeton, New Jersey |

☒ *Additional inventors are being named on the 1 separately numbered sheets attached hereto*

**TITLE OF THE INVENTION (280 characters max)**

VIDEO COMFORT NOISE

**CORRESPONDENCE ADDRESS**

*Direct all correspondence to:*

☐ Customer Number [ ] → *Place Customer Number Bar Code Label here*

OR *Type Customer Number here*

| | | | | | |
|---|---|---|---|---|---|
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**ENCLOSED APPLICATION PARTS *(check all that apply)***

☒ Specification *Number of Pages* 5 ☐ CD(s), Number [ ]

☐ Drawing(s) *Number of Sheets* [ ] ☐ Other (specify) [ ]

☐ Application Data Sheet. See 37 CFR 1.76

**METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)***

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

FILING FEE AMOUNT ($)

☒ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 07-0832 — 160

☐ Payment by credit card. Form PTO-2038 is attached.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: ____.

*Respectfully submitted,*

SIGNATURE _____ Date 8/20/03

TYPED or PRINTED NAME Robert B. Levy REGISTRATION NO. *(if appropriate)* 28,234

TELEPHONE 609 734-6820 Docket Number: PU030249

## USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

# PROVISIONAL APPLICATION COVER SHEET
*Additional Page*

PTO/SB/16 (02-01)
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| Docket Number | PU030249 | Type a plus sign (+) inside this box → | + |
|---|---|---|---|

| INVENTOR(S)/APPLICANT(S) | | |
|---|---|---|
| Given Name (first and middle (if any)) | Family or Surname | Residence (City and either State or Foreign Country) |
| Jeffrey Allen | Cooper | Rocky Hill, New Jersey |



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# FEE TRANSMITTAL for FY 2003

*Effective 01/01/2003. Patent fees are subject to annual revision.*

☐ Applicant claims small entity status. See 37 CFR 1.27

**TOTAL AMOUNT OF PAYMENT** ($) 160

| *Complete if Known* | |
|---|---|
| Application Number | |
| Filing Date | |
| First Named Inventor | Jill MacDonald Boyce |
| Examiner Name | |
| Group / Art Unit | |
| Attorney Docket No. | PU030249 |

## METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number: 07-0832

Deposit Account Name: Thomson Licensing Inc.

**The Commissioner is authorized to:** *(check all that apply)*
☒ Charge fee(s) indicated below ☒ Credit any overpayments
☒ Charge any additional fee(s) during the pendency of this application
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## FEE CALCULATION

### 1. BASIC FILING FEE

| Large Entity Fee Code | Large Entity Fee ($) | Small Entity Fee Code | Small Entity Fee ($) | Fee Description | Fee Paid |
|---|---|---|---|---|---|
| 1001 | 750 | 2001 | 375 | Utility filing fee | |
| 1002 | 330 | 2002 | 165 | Design filing fee | |
| 1003 | 520 | 2003 | 260 | Plant filing fee | |
| 1004 | 750 | 2004 | 375 | Reissue filing fee | |
| 1005 | 160 | 2005 | 80 | Provisional filing fee | 160 |

SUBTOTAL (1) ($) 160

### 2. EXTRA CLAIM FEES

| | | | Extra Claims | | Fee from below | = | Fee Paid |
|---|---|---|---|---|---|---|---|
| Total Claims | | -20 ** | 0 | X | | = | 0 |
| Independent Claims | | -3 ** | 0 | X | | = | 0 |
| Multiple Dependent | | | | X | | = | 0 |

| Large Entity Fee Code | Large Entity Fee ($) | Small Entity Fee Code | Small Entity Fee ($) | Fee Description |
|---|---|---|---|---|
| 1202 | 18 | 2202 | 9 | Claims in excess of 20 |
| 1201 | 84 | 2201 | 42 | Independent claims in excess of 3 |
| 1203 | 280 | 2203 | 140 | Multiple dependent claim, if not paid |
| 1204 | 84 | 2204 | 42 | ** Reissue independent claims over original patent |
| 1205 | 18 | 2205 | 9 | ** Reissue claims in excess of 20 and over original patent |

SUBTOTAL (2) ($) 0

**or number previously paid, if greater; For Reissues, see above

## FEE CALCULATION (continued)

### 3. ADDITIONAL FEES

| Large Entity Fee Code | Large Entity Fee ($) | Small Entity Fee Code | Small Entity Fee ($) | Fee Description | Fee Paid |
|---|---|---|---|---|---|
| 1051 | 130 | 2051 | 65 | Surcharge - late filing fee or oath | |
| 1052 | 50 | 2052 | 25 | Surcharge - late provisional filing fee or cover sheet. | |
| 1053 | 130 | 1053 | 130 | Non-English specification | |
| 1812 | 2,520 | 1812 | 2,520 | For filing a request for reexamination | |
| 1804 | 920* | 1804 | 920* | Requesting publication of SIR prior to Examiner action | |
| 1805 | 1,840* | 1805 | 1,840* | Requesting publication of SIR after Examiner action | |
| 1251 | 110 | 2251 | 55 | Extension for reply within first month | |
| 1252 | 410 | 2252 | 205 | Extension for reply within second month | |
| 1253 | 930 | 2253 | 465 | Extension for reply within third month | |
| 1254 | 1,450 | 2254 | 725 | Extension for reply within fourth month | |
| 1255 | 1,970 | 2255 | 985 | Extension for reply within fifth month | |
| 1401 | 320 | 2401 | 160 | Notice of Appeal | |
| 1402 | 320 | 2402 | 160 | Filing a brief in support of an appeal | |
| 1403 | 280 | 2403 | 140 | Request for oral hearing | |
| 1451 | 1,510 | 1451 | 1,510 | Petition to institute a public use proceeding | |
| 1452 | 110 | 2452 | 55 | Petition to revive – unavoidable | |
| 1453 | 1,300 | 2453 | 650 | Petition to revive – unintentional | |
| 1501 | 1,300 | 2501 | 650 | Utility issue fee (or reissue) | |
| 1502 | 470 | 2502 | 235 | Design issue fee | |
| 1503 | 630 | 2503 | 315 | Plant issue fee | |
| 1460 | 130 | 1460 | 130 | Petitions to the Commissioner | |
| 1807 | 50 | 1807 | 50 | Processing fee under 37 CFR 1.17 (q) | |
| 1806 | 180 | 1806 | 180 | Submission of Information Disclosure Stmt | |
| 8021 | 40 | 8021 | 40 | Recording each patent assignment per property (times number of properties) | |
| 1809 | 750 | 2809 | 375 | Filing a submission after final rejection (37 CFR § 1.129(a)) | |
| 1810 | 750 | 2810 | 375 | For each additional invention to be examined (37 CFR § 1.129(b)) | |
| 1801 | 750 | 2801 | 375 | Request for Continued Examination (RCE) | |
| 1802 | 900 | 1802 | 900 | Request for expedited examination of a design application | |

Other fee (specify) ____

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 0

| SUBMITTED BY | | | | Complete *(if applicable)* | |
|---|---|---|---|---|---|
| *Name (Print/Type)* | Robert B. Levy | *Registration No. Attorney/Agent)* | 28,234 | *Telephone* | 609-734-6820 |
| *Signature* | | | | *Date* | August 20, 2003 |

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PU030249

**A. Brief summary of the invention**

Video compression at low bitrates tends to cause visible artifacts that are noticeable to a viewer. The human visual system causes some types of artifacts to be more noticeable and objectionable than others. Addition of random noise can reduce the noticeability of compression artifacts, but large frame-to-frame differences created by random noise addition are themselves noticeable and objectionable. In this invention, temporal correlation is used in the creation of the additive comfort noise pattern to reduce the amount of frame-to-frame differences.

**B. Keywords: list keywords or combinations of keywords to guide patent and literature searches. Underline the most important keywords.**

H.264, JVT, MPEG AVC
dither
comfort noise

**C. Brief discussion of the problem solved by the invention**

Video compression at low bitrates tends to cause visible artifacts that are noticeable to a viewer. The human visual system causes some types of artifacts to be more noticeable and objectionable than others. Blockiness and structured noise patterns are common artifacts in block-based image and video compression techniques. Addition of random noise can reduce the noticeability of compression artifacts, but large frame-to-frame differences created by random noise addition are themselves noticeable and objectionable.

**D. Discussion of how you or others have implemented similar things in the past, including the manner in which others have attempted to solve the problem. Point out disadvantages and weaknesses in previous practice. Include literature references where available.**

It is well known that addition of a dither signal can reduce human sensitivity to image artifacts, for example to hid contouring and blocking artifacts. In [1], a random noise dither based on film grain is added to an image to hide block effects, with the rationale "random error is more forgiving than the structure, or correlated error."

It has also been previously proposed that a dither signal be added to video sequences to hide compression artifacts. In [2], it was proposed that a random noise dither be added in the video encoding and decoding process in the in loop deblocking filter for the JVT video coding standard [3]. The amount of dither to be added depended on the position of a pixel with respect to a block edge.

The term "comfort noise" is used in audio compression to indicate noise pattern generated at the receiver end, to avoid total silence that is uncomfortable to a listener.

It was proposed in [4] that random noise be added as a postprocess to video decoding, for use as comfort noise. The amount of noise added depends on the quantization parameter and the amount of noise added to spatially neighboring pixels.


[1] S. Yang, Y. Hu, "Blocking Effect Removal Using Regularization and Dithering", ICIP 1998, p. 415-419.

[2] G. Conkin, N. Gokhale, JVT-C-56, "Dithering 5-tap Filter for Inloop Deblocking," ftp://ftp.imtc-files.org/jvt-experts/2002_-5_Fairfax/JVT-C056.doc

[3] T. Wiegand, JVT Study of Final Committee Draft, Dec 5-13, 2002, ftp://ftp.imtc-files.org/jvt-experts/2002_12_Awaji/JVT-F100d1ncm.zip

[4] G. Bjontegaard, "Addition of 'comfort noise' as post processing", ITU-T SG 16 Q15-B-15.


E. Description of the invention, including one or more practical embodiments of the invention in sufficient detail to allow one with ordinary skill in the art to practice the invention. Include schematic(s), flow chart(s) and/or figures to clarify operation of the invention. Point out important features and items you believe to be new. State advantages of the invention and sacrifices, if any, made to achieve these advantages. Describe any experiments conducted and the results of those experiments.

A dither signal containing random noise is added to the pictures in a video sequence, after video compression decoding, to improve the subjective video quality. Figure 1 shows a receiver end system, which includes a video decoder and a comfort noise generator. The generated noise is added to the decoded pictures prior to display. The addition of the comfort noise occurs after reference picture storage, as the reference pictures must be unchanged in order to properly decode the following pictures. Figure 2 shows another receiver end system, in which the noise generator uses as input the decoded picture, and other bitstream information from the video decoder. Figure 2 is compatible with the comfort noise generation described in [4], in which the quantization parameter is the Bitstream information passed from the video decoder to the noise generator.

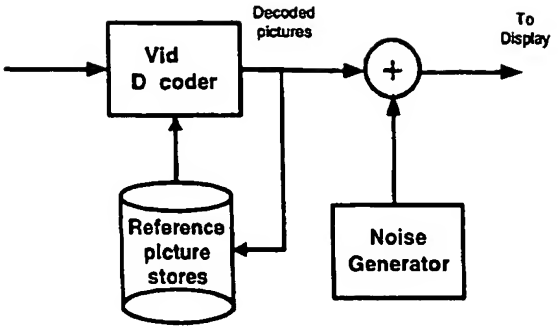


Figure 1.

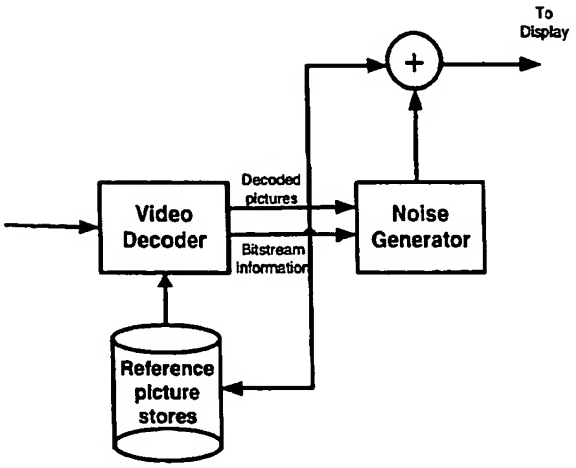


Figure 2.

In this invention, the determination of the magnitude of the noise signal to add is based on any of several different factors. Let N(k, x, y) be the added pixel noise signal, P (k, x, y) be the decoded pixel, and D (k, x, y) be the displayed pixel (x, y) of the k-th picture in the video sequence, respectively. The displayed pixel of the picture is the decoded pixel plus the noise signal,

$$D(k, x, y) = P(k, x, y) + N(k, x, y)$$

The visual impact of adding a noise signal to the video sequence, rather than just to a single image, is considered in the determination of the magnitude of the noise signal. The magnitude of additive noise signal for a pixel in a picture is correlated to the value of the additive noise signal of the pixels in the previously displayed picture, e.g., the noise signals are temporally correlated. In an alternative embodiment of the current invention,

the temporal correlation is based on the previously decoded picture, rather than the previously displayed picture.

In an embodiment of the current invention, the added noise signal using temporal correlation, with correlation factor $\alpha$, $0 \leq \alpha \leq 1$, is computed as

$$N(k, x, y) = \alpha\, N(k-1, x, y) + (1 - \alpha)\, R(k, x, y) \qquad \text{(Eq. 1)}$$

The random number R(k, x, y) may be generated using any type of random number distribution, for example a Gaussian or Laplacian distribution. The random number generator may be implemented by means of a lookup table. R(k, x, y) may also include spatial correlation, such as that used for example in film grain noise generation.

Because $\alpha$ is fractional, to avoid divisions, Eq. 1 can be simplified,

$$N(k, x, y) = (a * N(k-1, x, y) + (2^b - a)\, R(k, x, y) + 2^{b-1}) >> b \quad \text{(Eq 2)}$$

Figure 3 shows a receiver-end system that includes a noise generator compatible with Eq. 1 or Eq. 2. In Figure 3, the noise signal N(k, x, y) for the k-th picture is stored in the noise picture store.

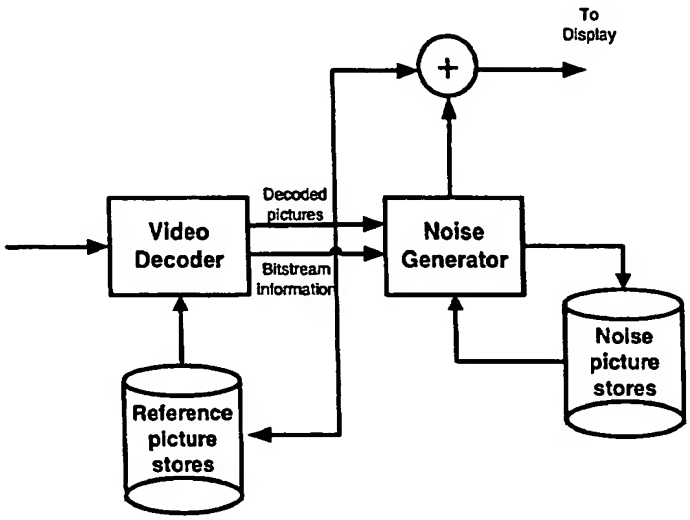


Figure 3.

The system of Figure 3 requires more memory bandwidth than the system of Figure 1, because for each displayed picture the previous displayed picture's noise signal picture must be accessed and the current picture's noise signal picture must be stored.

The system of Eq. 1 and Figure 3 is implementation is an instantiation of a temporal IIR filter. The IIR filter may be generalized by using more filter taps. IIR filters can also generally be approximated using higher order FIR filters, using as many taps, t, as desired.

$$N(k,x,y) = \sum_{i=0}^{t-1} \alpha^{i+1} N(k-i, x, y) + \alpha^{i}(1-\alpha) R(k-i, x, y) \quad \text{(Eq 3)}$$

An FIR filter approach can be implemented using the system of Figure 2. Only the previous random numbers R, rather than the previous noise, N, is used in an FIR filter approach, so memory bandwidth is reduced.

Possible claims:

1. Add temporally correlated noise as a postprocess following video decoder
2. Claim 1 using a correlation factor alpha
3. Claim 1 with FIR filter implementation

# Document made available under the Patent Cooperation Treaty (PCT)

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